



**HARGIS + ASSOCIATES, INC.**  
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January 17, 2008

VIA E-MAIL AND FEDERAL EXPRESS STANDARD

Dr. Marysia Skorska & Mr. Brian Rakvica  
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION  
2030 E. Flamingo Road, Suite 230  
Las Vegas, NV 89119

Re: Proposed Path Forward to Develop Multiple Lines of Evidence for Plume Capture;  
Henderson Groundwater Treatment System, Henderson, Nevada

Dear Dr. Skorska and Mr. Rakvica:

Pursuant to a request from the Nevada Department of Environmental Protection (NDEP) in letters dated July 20 and August 8, 2007, this letter has been prepared on behalf of Montrose Chemical Corporation of California, Stauffer Management Company LLC (SMC)/Syngenta, and Olin Chlor-Alkali Corporation, hereafter referred to as "the Companies" to describe a process to identify and utilize multiple lines of evidence to assess the extent of capture being achieved by the groundwater treatment system (GWTS) located at the Henderson, Nevada site. As discussed in previous correspondence, there are numerous possible lines of evidence that may be used to evaluate capture. Some are more useful, accurate, or cost efficient than others depending on the specific characteristics of the system being evaluated.

At this time, the Companies feel there is insufficient information available to make a proper selection of which lines of evidence are most appropriate for the GWTS. Hence, it is necessary to perform certain field work to assist in that selection. It is the Companies intention to complete the field work identified in this letter, provide to NDEP an assessment of the selection of which lines of evidence should be used, and upon NDEP's concurrence, proceed forward with implementing those methods within the normal quarterly evaluations of the GWTS performance.

Based on correspondence among NDEP and the Companies (NDEP, 2007a and 2007b), there are a number of possible lines of evidence that could be used to evaluate plume capture. Among these potential lines of evidence are the following as identified in U.S. Environmental Protection Agency's (EPA's) guidance documents entitled "*Elements for Effective Management of Operating Pump and Treat System, EPA 542-R-02-009, U.S. EPA December 2002*" and "*Capture Zone Analysis for Pump and Treat Systems, U.S. EPA May 2005*".

Other Offices:  
Mesa, AZ  
Tucson, AZ

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1. Calculations of capture zone width based on flow budget and/or analytical models
2. Interpretation of groundwater flow lines from potentiometric surface maps that are based on measured groundwater elevations
3. Inward flow relative to a compliance boundary based on measured groundwater elevations at two or more locations oriented perpendicular to the boundary
4. Concentration trends over time at sentinel wells located down gradient of the capture zone
5. Particle tracking in conjunction with a numerical groundwater flow model calibrated/verified by actual groundwater elevations under pumping conditions
6. Implementation and analysis of data from tracer tests

In addition to the above lines of evidence provided in these EPA documents, NDEP (NDEP, 2007a and 2007b) has indicated that the following additional lines of evidence may be utilized:

7. Demonstrating overlapping cones of depression (based on water levels in piezometers, not in pumping wells);
8. Use of non-pumping wells around the wellfield to construct three-point gradient solutions; and
9. Use of nested monitor wells to demonstrate that there is an upward vertical gradient, i.e., that the plume does not flow beneath the extraction wells.

Further, an additional line of evidence as discussed between Tronox and NDEP (ENSR 2007; NDEP, 2007c) as related to the Tronox capture assessment program is the use of a mass balance approach to assess the wellfield capture efficiency.

It is the Companies understanding that NDEP requires that a minimum of three lines of evidence be utilized to demonstrate capture (NDEP, 2007a). However, before these lines of evidence can be fully evaluated to select which are most useful to the GWTS, currently planned field work must be completed and a number of data gaps must be resolved. The following sections provide a brief summary of the field work currently planned and a description of the data gaps and the work proposed to address them.

### **CURRENTLY PLANNED FIELD WORK**

Based on the evaluation of intersecting cones of depression work conducted in mid-2007 (H+A, 2007b), a possible area where drawdown may not overlap was identified in the current extraction well line between existing extraction wells J and D2. As discussed in the Extraction Well Testing Program Report (H+A, 2007b), a new extraction well N has been designed and is planned for installation in the first quarter of 2008.

Additionally, review of the performance records of existing extraction well M has indicated the well has reached the end of its useful life and a plan has been developed to replace well M with well M2 also in the first quarter of 2008 (Figure 1). Because operation of these two new wells

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may change the characteristics of the extraction wellfield, the Companies believe these wells should be in operation to assist in determining which lines of evidence are selected for future routine capture analysis.

The following summarizes two other current programs that will provide data which will assist in the evaluation of capture:

1. Evaluation of a Downgradient Monitoring Transect (H+A, 2008) – this work will be conducted to establish a groundwater monitoring transect down gradient from the GWTS. Data will be collected to characterize the thickness of the alluvial aquifer, sediment types, water levels, and water quality. Data obtained from this program will allow assessment of concentration trends at the downgradient transect wells and mass flux reduction.
2. Evaluation of the Muddy Creek Formation (H+A, 2007c) – this work will be conducted to evaluate the horizontal and vertical extent of site-related chemicals in the Muddy Creek Formation, in the vicinity of the GWTS. Data will include water quality and water level data in the Muddy Creek Formation. Data will be used to assess vertical gradients between the Muddy Creek Formation and the alluvial aquifer and the potential for plume migration beneath the wellfield.

### **DATA GAPS**

The evaluation for many of the listed lines of evidence depends on the availability of extensive water level measurements in the vicinity of the extraction zone. While numerous monitoring points are currently available in the GWTS area, there are several critical locations where water level data are lacking. These data gaps and the proposed additional assessment required to fill these data gaps are described in the following section.

### **Drawdown at Extraction Wells**

In order to evaluate drawdown and the water table configuration near the extraction wells, accurate water level data that are representative of the formation are needed. Pumping water levels in extraction wells can not be used for this purpose due to the additional drawdown caused by well losses. To resolve this issue, water level piezometers will be installed adjacent to each extraction well where an existing well in close proximity is not already available. Currently, eight existing extraction wells, A, B, C, J, F, G, K2, and M, and the planned new extraction well N do not have a well or piezometer located in close proximity that can be used to monitor the formation drawdown near the extraction well (Figure 1). Although well M does not currently have an adjacent well, as noted above, the extraction well is scheduled to be replaced. The replacement extraction well M2 will be constructed in close proximity to the old well such that the old well can serve as the adjacent water level piezometer.

Therefore, to provide accurate water level data near all extraction wells, a total of eight new water level piezometers, MC-116 to MC-123, will be installed (Figure 1, Table 1).

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### **Drawdown between Extraction Wells**

In order to confirm the drawdown configuration around the extraction wells, water level measuring locations are needed between extraction wells. Based on the configuration of the extraction well line once new well N is installed, it is planned that 3 additional water level piezometers be installed (Figure 1, Table 1) as noted below.

- New piezometer MC-124 will be installed at the midpoint between extraction wells C and J. These extraction wells are separated by more than 300 feet and there is currently no monitor well in this vicinity to monitor the drawdown and confirm whether their cones of depression overlap.
- New piezometer MC-125 will be installed at the midpoint between extraction well J and proposed extraction well N. These extraction wells will be separated by approximately 180 feet and there is currently no monitor well in this vicinity to monitor the drawdown due to these extraction wells and confirm whether their cones of depression overlap.
- New piezometer MC-126 will be installed at the midpoint between extraction wells D2 and E3. These extraction wells are separated by approximately 170 feet and there is currently no monitor well in this vicinity to monitor the drawdown due to these extraction wells and confirm whether their cones of depression overlap.

### **Water Level Contour Control on the Eastern Extent of the GWTS**

Additional water level data are also needed on the east end of the extraction wellfield to confirm the extent of drawdown east of extraction well I and the orientation of the water level contours and hence the direction of groundwater flow on the east end of the wellfield (Figure 1). The extent of drawdown and orientation of the water level contours is not well constrained by the available data in this area as monitor well MC-32 is dry. This indicates that the alluvial aquifer pinches out in that direction and an additional water level piezometer, MC-127, is therefore recommended in this area to assess drawdown, define the groundwater flow direction, and estimate the extent of the alluvial aquifer and capture in this area (Figure 1, Table 1).

### **Piezometer Construction**

The proposed water-level piezometers will be constructed with 2-inch schedule 40 PVC casing and screen in accordance with Section 7.5.2 of the Field Sampling and Standard Operating Procedures, Site-Wide Soil and Groundwater Investigations, Former Montrose and Stauffer Sites, Henderson Nevada Revision 2.0 (H+A, 2007a) with the following exceptions:

- Piezometers will be single completion rather than dual completion piezometers;
- Piezometers will be installed in a minimum 6-inch diameter borehole drilled to the base of the alluvium; and
- Piezometers will be screened from near the water table to the base of the alluvium.

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### **IDENTIFICATION OF PREFERRED LINES OF EVIDENCE**

Once the field data is obtained it will be compiled and evaluated in accordance with the potential lines of evidence listed above. It is anticipated that some lines of evidence will have greater uncertainty and are therefore less reliable indicators of the extent of capture. A summary report will be prepared and submitted to NDEP that identifies which three lines of evidence are recommended for use with NDEP concurrence to assess the extent of capture of the GWTS on a routine basis. The report will provide a summary of the field activities conducted as part of this workplan as well as the results of the evaluation of each of the three supporting lines of evidence including any pertinent back-up tables, graphs, and figures.

### **SCHEDULE**

Upon NDEP's concurrence with this workplan, a proposed schedule will be prepared and submitted to NDEP. It should be noted that some of the data required to evaluate the various lines of evidence for capture described in this workplan will be collected during completion of various field programs scheduled for completion in 2008. Since the completion of those programs is sometimes dependent on outside factors, such as obtaining access or NDEP approval of related workplans, the schedule for finalizing capture zone assessment has some uncertainty. NDEP will be kept apprised of any significant delays that are identified as the task progresses.

### **JURAT**

*I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances.*

For the services provided and attested to with this Jurat including the preparation of this letter.



Michael A. Palmer, PG, CEM  
Principal Hydrogeologist  
Nevada Certified Environmental Manager  
No. EM - 2122 (Expires 10/19/09)

Date Signed: January 17, 2008

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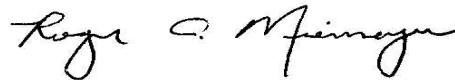
If you have any questions, please contact us at 619-521-0165.

Sincerely,

HARGIS + ASSOCIATES, INC.



Michael A. Palmer, PG 5915, CEM 2122  
Principal Hydrogeologist



Roger A. Niemeyer, PG 3616, CHG 43 CEG 1071  
Principal Hydrogeologist

MAP/RAN/ama

Enclosure

cc: Mr. Paul Sundberg, Consultant to Montrose Chemical Corporation of California  
Mr. Joe Kelly, Montrose Chemical Corporation of California  
Mr. George Crouse, Syngenta Crop Protection, Inc.  
Mr. Larry Hall, Consultant to Stauffer Management Company LLC  
Mr. Lee Erickson, Consultant to Stauffer Management Company LLC  
Mr. Kelly McIntosh, Geomatrix Consultants, Inc.  
Mr. Mike Belloti, Olin Chlor-Alkali Corporation  
Mr. Curt Richards, Olin Chlor-Alkali Corporation  
Mr. Ed Modiano, *de maximis, inc.*

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## REFERENCES

- ENSR Corporation, 2007. Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada. August 29, 2007.
- Hargis + Associates, Inc., 2007a, Field Sampling and Standard Operating Procedures, Site-Wide Soil and Groundwater Investigations, Former Montrose and Stauffer Sites, Henderson, Nevada, Revision 2.0. May 11, 2007.
- \_\_\_\_\_, 2007b. Groundwater Treatment System, Extraction Well Testing Program, Henderson, Nevada. June 15, 2007.
- \_\_\_\_\_, 2007c. Workplan to Evaluate the Impact of the Groundwater Treatment System on the Fine-Grained Upper Muddy Creek Formation, Henderson, Nevada. November 19, 2007.
- \_\_\_\_\_, 2008. Downgradient Transect Upgrade Workplan, Henderson Groundwater Treatment System, Henderson, Nevada. January 4, 2008.
- Nevada Division of Environmental Protection, 2007a. Letter to B. Spillar, Stauffer Management Company LLC, L. Landry, Pioneer Americas LLC, and J. Kelly, Montrose Chemical Corporation of California, Re: Deliverables Request to Address the Henderson Ground Water Treatment System, NDEP Facility ID # H-000536 and H-000540, dated July 20, 2007.
- \_\_\_\_\_, 2007b. Letter to B. Spiller, Stauffer Management Company LLC, L. Landry, Pioneer Americas LLC, and J. Kelly, Montrose Chemical Corporation of California, Re: Nevada Division of Environmental Protection Comments for: Groundwater Treatment System Extraction Wells Testing Program, Henderson, Nevada, dated June 15, 2007, NDEP Facility ID # No. H-000536 and NDEP Facility ID # H-000540, dated August 8, 2007.
- \_\_\_\_\_, 2007c. Letter to S. Crowley, Tronox LLC, Re: Nevada Division of Environmental Protection Response to: Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada, Dated August 29, 2007, NDEP Facility ID # H-000539, dated October 3, 2007.
- U.S. Environmental Protection Agency, 2002. Elements for Effective Management of Operating Pump and Treat Systems, EPA 542-R-02-009, OSWER 9355.4-27 FS-A. Prepared by GeoTrans. December 2002.
- \_\_\_\_\_, 2005. Capture Zone Analyses for Pump-and-Treat Systems. EPA Training Course Presented To: State of Arizona. May 25, 2005.

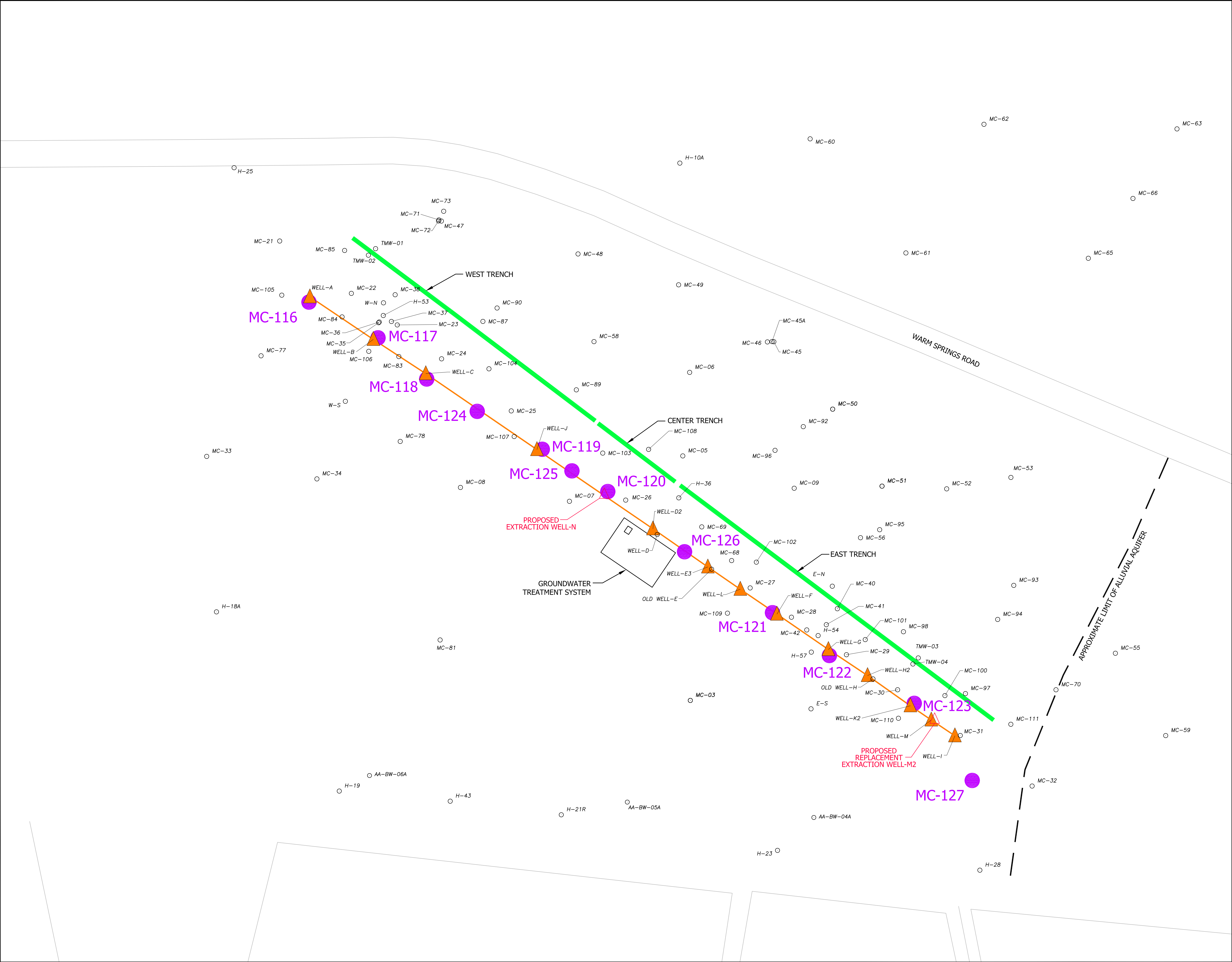
**TABLE 1**  
**PLANNED WATER LEVEL PIEZOMETERS**

PIEZOMETER IDENTIFIER	PIEZOMETER LOCATION	PURPOSE
MC-116	Adjacent to extraction well A.	Provide water level drawdown data for extraction well A.
MC-117	Adjacent to extraction well B.	Provide water level drawdown data for extraction well B.
MC-118	Adjacent to extraction well C.	Provide water level drawdown data for extraction well C.
MC-119	Adjacent to extraction well J.	Provide water level drawdown data for extraction well J.
MC-120	Adjacent to proposed extraction well N.	Provide water level drawdown data for extraction well N.
MC-121	Adjacent to extraction well F.	Provide water level drawdown data for extraction well F.
MC-122	Adjacent to extraction well G.	Provide water level drawdown data for extraction well G.
MC-123	Adjacent to extraction well K2.	Provide water level drawdown data for extraction well K2.
MC-124	The midpoint between extraction well C and extraction well J.	Provide water level drawdown data and confirm cone of depression overlap.
MC-125	The midpoint between extraction well J and proposed extraction well N.	Provide water level drawdown data and confirm cone of depression overlap.
MC-126	Approximately half way between extraction well D2 and extraction well E3.	Provide water level drawdown data and confirm cone of depression overlap.
MC-127	Eastern extent of extraction well field.	Define the water level conditions and monitor drawdown in the area east of the extraction well field.

**NOTES:**

1. Piezometers MC-116 through MC-123 will be drilled within 15 feet of their associated extraction wells. Each piezometer will be surveyed by a State of Nevada licensed surveyor upon the completion of piezometer installation activities.
2. Specific piezometer construction details will be determined in the field based on lithologic conditions encountered during piezometer drilling activities.





**EXPLANATION**

MC-63 WELL OR SOIL BORING IDENTIFIER

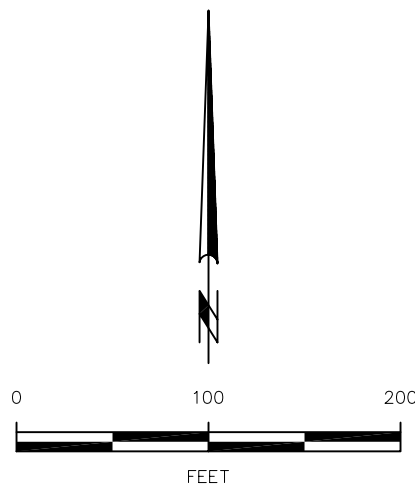
○ GROUNDWATER WELL


▲ GROUNDWATER EXTRACTION WELL

● PROPOSED WATER LEVEL MONITORING PIEZOMETER

△ PROPOSED GROUNDWATER EXTRACTION WELL

RECHARGE TRENCH



GROUNDWATER TREATMENT SYSTEM AREA HENDERSON, NEVADA		
<b>PROPOSED WATER LEVEL MONITORING PIEZMOETERS</b>		
	HARGIS+ASSOCIATES, INC. Hydrogeology/Engineering	1/08
PREP BY GLW, REV BY RAN, RPT NO. 754.42		FIGURE 1 410-6545